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Datasheet for the decision of 4 October 2011

Case Number: T 1772/08 - 3.5.02

Application Number: 03006099.0

Publication Number: 1347559

IPC: H02K 15/00

Language of the proceedings: EN

Title of invention:
Wound stator of a rotary electric machine and its winding method

Applicant:
DENSO CORPORATION

Headword:
-

Relevant legal provisions:
EPC Art. 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step - (yes) after amendment"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1772/08 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 4 October 2011

Appellant: DENSO CORPORATION
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 6 June 2008 refusing European patent application No. 03006099.0 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: M. Ruggiu
Members: M. Léouffre
R. Moufang

Summary of Facts and Submissions

I. This is an appeal of the applicant against the decision of the examining division to refuse European patent application No. 03006099.0

II. The reason given for the refusal was essentially that the application did not meet the requirements of Article 52(1) EPC because the subject-matter of claims 1 and 3 of the main request and the subject-matter of claim 1 of the auxiliary request, filed at the oral proceedings before the examining division, did not involve an inventive step in the sense of Article 56 EPC.

III. The following documents of the state of the art have been cited during the procedure before the first instance:

D1: EP-A-1 187 299;
D2: EP-A-1 005 137;
D3: EP-A-1 330 012; and
D4: JP 2000-164043.

IV. In its letter dated 07 August 2008, which contained a notice of appeal as well as a statement of grounds of appeal, the appellant requested the grant of a patent on the basis of the documents of the main request, or alternatively of the auxiliary request, as defined in item 1.3 of the appealed decision. The appellant argued that the interpretation of the content of the closest prior art D1 given to this document by the examining division, resulted "from an unpermittable hindsight in knowledge of the teaching of the present application."

V. In a communication accompanying a summons to oral proceedings dated 19 July 2011, the board indicated its preliminary opinion that the subject-matter of claims 1 and 3 of the main request and claim 1 of the auxiliary request extended beyond the content of the application as filed (Article 123(2) EPC) and was not novel (Article 54(1) and (3) EPC) having regard to D3 and did not involve an inventive step in the light of D1 (Article 56 EPC).

VI. The appellant filed a new set of claims 1 to 8 of a main request together with corresponding description pages 1, 2 and 2a, and another set of claims 1 to 6 of a first auxiliary request together with corresponding description pages 1, 2 and 2a with a letter dated 2 September 2011.

VII. Oral proceedings before the board took place on 4 October 2011. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 8 of a main request, filed at the oral proceedings, or claims 1 to 6 of an auxiliary request, also filed at the oral proceedings.

Furthermore, the applicant filed amended description pages 1, 2, 13 and 14 at the oral proceedings to be considered for the auxiliary request (together with pages 3 to 12 of the originally filed description, page 2a filed with letter dated 2 September 2011 as page 2a of the amended description according to the then auxiliary request, and figures 1 to 9 as originally filed).

VIII. Claim 1 of the main request reads as follows:

"A stator for an electric rotating machine (1), said stator comprising
a plurality of conductors (331, 332) in form of U-shaped continuous conducting segments, each segment having a substantially rectangular cross-section, said conductors passing through slots (35) of a stator core (32) of the electric rotating machine (1);
wherein said plurality of conductors (331, 332) are lined up in each slot (35) in a radial direction of the stator core (32);
wherein each conductor (331, 332) has housed portions housed in the slots (35) and protruded end portions protruded from the stator core (32);
wherein each protruded end portion has a connecting portion (331d, 331d', 331e, 331e', 332d, 332d') that extends in a circumferential direction of the stator core (32) at an angle with respect to a radial section of the stator core (32) for connecting with another conductor (331, 332) protruded from a different slot (35), and an altered portion having a bare portion (331h, 332h) at an end of the connecting portion (331d, 331d', 331e, 331e', 332d, 332d'), each conductor being coated with an insulating layer (37) except for said bare portion (331h, 332h); and
wherein each end portion (331g, 332g) of the connecting portions is bent in radial direction of the stator core by more than a thickness of said insulating layer (37) in such way that the bare portion (331h, 332h) of one conductor is brought in contact for connection and is connected with the bare portion (331h, 332h) of another conductor."

Claim 2 of the main request reads as follows:

"A method for manufacturing a stator of an electric rotating machine (1), comprising:
passing conductors (331, 332) of substantially rectangular cross section, coated with insulating layers (37), through each of a plurality of slots (35) provided in a stator core (32) of the electric rotating machine so that the conductors (331, 332) are lined up in each slot (35) in a radial direction of the stator core (32) and ends of the conductors (331, 332) are protruded from the slots (35);
shaping protruded portions of the conductors (331, 332) to form a connection portion (331d, 331d', 331e, 331e', 332d, 332d') that extend in a circumferential direction of the stator core (32) at an angle with respect to a radial section of the stator core (32) and adjacent conductors (331, 332) extend in opposite directions;
connecting the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') of conductors in pairs that are closely positioned in the connecting portion shaping step;
altering an end of the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') so that a distance between ends of the connecting portions (331d, 331d', 331e, 331e', 332d, 332d') of the pair decreases towards ends thereof;
wherein the insulating layers (37) are removed from ends of the conductors (331, 332),
wherein the altering step is performed to bring the ends of the adjacent conductors, wherefrom the insulating layers have been removed, in contact for connection."

Claims 3 to 8 of the main request are dependent on claim 2.

Claim 1 of the auxiliary request reads as follows:

"A method for manufacturing a stator of an electric rotating machine (1), comprising:
passing conductors (331, 332) of substantially rectangular cross section, coated with insulating layers (37), through each of a plurality of slots (35) provided in a stator core (32) of the electric rotating machine so that the conductors (331, 332) are lined up in each slot (35) in a radial direction of the stator core (32) and ends of the conductors (331, 332) are protruded from the slots (35);
shaping protruded portions of the conductors (331, 332) to form a connection portion (331d, 331d', 331e, 331e', 332d, 332d') that extend [sic] in a circumferential direction of the stator core (32) at an angle with respect to a radial section of the stator core (32) and adjacent conductors (331, 332) extend in opposite directions;
connecting the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') of conductors in pairs that are closely positioned in the connecting portion shaping step;
altering an end of the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') so that a distance between ends of the connecting portions (331d, 331d', 331e, 331e', 332d, 332d') of the pair decreases towards ends thereof;
wherein the insulating layers (37) are removed from ends of the conductors (331, 332),

wherein the altering step is performed to bring the ends of the adjacent conductors, wherefrom the insulating layers have been removed, in contact for connection;
wherein the altering step includes:
shaping the end of the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') so that an end thereof approaches toward a position that the connecting portion (331d, 331d', 331e, 331e', 332d, 332d') of the other conductor (331, 332) is placed; and wherein passing a plurality of conductors (331, 332), after having the connecting portions (331d, 331d', 331e, 331e', 332d, 332d') shaped in the altering step, through each slot (35)."

Claims 2 to 6 of the auxiliary request are dependent on claim 1.

IX. The appellant essentially argued as follows:

Document D3, which is a document falling under Article 54(3) EPC does not give any hint whether the insulating coating of the conductor segments is removed at the connecting portions to create bare portions. The dimension h1 shown in figure 30B therefore cannot be considered as disclosing that "each portion of the connecting portions is bent in radial direction of the stator core by more than a thickness of said insulating layer in such a way that the bare portion of one conductor is brought in contact for connection and is connected with the bare portion of another conductor".

Document D1 mainly considers conductor segments with round or circular cross sections. When welding

conductors having circular or round cross sections with a process as shown in figure 8 of D1, molten metal tends to flow down to the insulating layers along the line of contact of the wires and to damage these layers. By contrast, conductors of substantially rectangular cross section would present a line of contact facing the torch 31 of figure 9 and would prevent therefore the flow of molten metal towards the insulating layers.
Further, although figure 12 of D1 shows conductor segments having substantially rectangular cross sections, D1 does not give any hint to combine the embodiments of figures 12 and 18.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

Claim 1 of the main request differs from claim 1 of the application as filed in that it relates to "a stator for an electric machine comprising a plurality of conductors in form of U-shaped continuous segments, each segment having a substantially rectangular cross-section".
Support for this feature may be found at lines 3 to 12 of page 2, in the paragraph bridging pages 8 and 9 and at lines 2 to 5 of page 13 of the original application.

Further, the following features of original claim 1
" and the altered portion is shaped so that a distance between the connector (331, 332) and the other

connector (331,332) decreases toward ends thereof and connected with the altered portion of the other connector (331,332)" have been replaced by the features "and an altered portion having a bare portion (331h, 332h) at an end of the connecting portion (331d, 331d', 331e, 331e', 332d, 332d'), each conductor being coated with an insulating layer (37) except for said bare portion (331h, 332h); and wherein each end portion (331g, 332g) of the connecting portions is bent in radial direction of the stator core by more than a thickness of said insulating layer (37) in such a way that the bare portion (331h, 332h) of one conductor is brought in contact for connection and is connected with the bare portion (331h, 332h) of another conductor."

The correction and replacement of the term "connector" found in the original feature by the term "conductor" complies with the requirements of Rule 139 EPC since it is immediately evident that the subject-matter of the present application as a whole, and of the claims in particular, concerns the conductors of the stator and not its connectors.

The original features aimed at defining the altered portions of each conductor. The altered portions are now defined by their end portions which are bent in such a way that their bare portions are brought in contact for connection. The bending of each bare portion of the conductors of a pair of conductors for bringing the said conductors in contact for connection, implies a distance between the said conductors which decreases towards the end of the altered portion.

The new features find support in the original application in the first paragraph of page 10, in the paragraph bridging pages 10 and 11 and in the passage from line 11 of page 12 to line 1 of page 13.

The board considers therefore that the subject-matter of claim 1 of the main request does not extend beyond the content of the original application as filed.

Claim 2 of the main request is based on original claim 3 wherein

- the conductors are further specified as being of "substantially rectangular cross section, and
- the insulating layers (37) are removed from ends of the conductors (331, 332); and
- the altering step is performed to bring the ends of the adjacent conductors, wherefrom insulating layers have been removed, in contact for connection.

The same passages as mentioned above provide support for these amendments.

Claim 1 of the auxiliary request is based on original claim 4 (which was dependent on claim 3) wherein the term "shaping" at the last line of original claim 4 has been replaced by the term "altering". Passing a plurality of conductors through the slots after having the connecting portions shaped in the shaping step would be impossible. Thus nothing else than the altering step can have been intended at the filing date and this correction is allowable under Rule 139 EPC. Since the further amendments with respect to original claim 4 are similar to those made to original claim 3, which serves as a basis for claim 2 of the main request, the board considers that the subject-matter of claim 1 of the auxiliary request does not extend beyond the content of the application as originally filed.

The description of the application has been amended to be consistent with the claims and acknowledges the prior art disclosed in documents D1 and D3.

Thus, the amendments to the application do not contravene Article 123(2) EPC.

3. *Novelty: main and auxiliary requests*

3.1 The earlier European patent application D3 was filed on 14 January 2003 with a claim to a priority of 18 January 2002. The designation fees for DE, FR, GB and IT were validly paid. This earlier application is therefore considered as comprised in the state of the art under Article 54(3) and 54(4) EPC 1973.
It discloses a stator for an electric machine (cf. page 1, lines 55 to 58), said stator comprising a plurality of conductors in form of U-shaped continuous conducting segments (cf. figure 3 and page 8, lines 33 to 36), each segment having a substantially rectangular cross-section (cf. page 8, line 34), said conductors passing through slots of a stator core of the electric machine; wherein a plurality of conductors are lined up in each slot in a radial direction of the stator core (cf. figure 2); wherein each conductor has housed portions (cf. page 9, lines 2 to 7 and reference numbers 331a, 332a, 331b, 332b on figure 3) that are housed in the slots, and protruded end portions (331, 332) that protrude from the stator core; wherein each protruded portion has a connecting portion that extends in a circumferential direction of the stator core at an angle with respect to a radial section of the stator core (cf. figures 4 and 5) for connecting with another conductor protruded from a different slot and an

altered portion (331d, 332d, 331e, 332e), each conductor being coated with an insulation layer (cf. page 4, lines 3, 4 and page 7, lines 54, 55).
The third embodiment disclosed in D3 comprises offsetting the ends of the connecting portions in the radial direction of the stator core by a distance sufficient to keep a clearance between the segments in such a way that the end portion of one conductor is brought in contact and is connected with the end portion of another conductor (cf. page 12, lines 41 to 45 and figures 28, 29). D3 further proposes in paragraph [0092] to keep the clearance between the conductor segments by bending the segments rather than offsetting the segments (cf. figures 30A, 30B). In that case, only the end portions of the conductors are in contact with each others (cf. paragraph [0102]).
Document D3 recites further at page 13, paragraphs [0093] to [0095] that the conductors of the third embodiment disclosed therein (cf. figures 26 to 30B) may be combined with conductors of the second embodiment and may be introduced into the slots (cf. page 13, lines 20 to 23) before welding (cf. page 12, lines 46 to 48).

Document D3 is silent about the thickness of the insulating layer of the conductor segments and does not specify if the insulating layer is removed at the end portion of the connecting portion for exposing a bare portion. At least, during welding the insulating layer will necessarily be removed e.g. by the heat of the welding process, and bare portions of adjacent conductors will be exposed and connected to each other. Thus, in D3, after the welding step, which corresponds to the electrical connecting step, the exposed bare

portion of a conductor will be in contact with the bare portion of the adjacent conductor.

Nevertheless it is not unambiguously derivable from D3 that the insulating layer has been removed from the end portions of the conductors segments, before the end portions of the conductor segments are altered and brought in contact with each other for connection. Hence, it cannot be derived unambiguously from D3 that the end portions of the connecting portions are bent in radial direction in such a way that the bare portion of one conductor is brought in contact for connection with the bare portion of another conductor.
It appears that, in the present application, at the time of bending an end of a connecting portion, a contact might be established between bare ends of a pair of U-shaped segments to be inserted in the same slots and not between the end portions of U-shaped segments that are to be electrically connected after the shaping process has taken place, that is, after the protruded portions are bent in the circumferential direction. Nevertheless this bending process has the consequence that two bare end portions of two U-shaped segments will be in contact for connection after the shaping process and before welding. The subject-matter of claims 1 and 2 is therefore considered as sufficiently defined and delimited over D3.

The subject-matter of claims 1 and 2 of the main request is therefore considered to be new having regard to document D3.
The subject-matter of claim 1 of the auxiliary request, which comprises all the features of claim 2 of the main

request, is consequently also considered to be new with respect to D3.

3.2 As regards D1, which is relevant prior art falling under Article 54(2) EPC, it discloses a stator for an electric rotating machine (cf. figure 7). Said stator comprises a plurality of conductors in form of U-shaped continuous conducting segments (cf. figure 6) passing through slots 16a of a stator core 16 of the electric machine. Said conductors are lined up in each slot in a radial direction and present housed portions 20a that are housed in the slots, and protruded end portions that protrude from the stator core. Each protruded end portion 20c has a connecting portion that extends in a circumferential direction of the stator core at an angle with respect to a radial section of the stator core for connecting with another conductor protruding from a different slot.
Each conductor presents an altered portion having a bare portion at an end of the connecting portion, each conductor being coated with an insulating layer except for said bare portion (cf. column 9, lines 37 to 39).

The embodiment shown in connection with figure 18 of D1 comprises conductor segments having round cross-section and having end portions 42b bent in radial direction of the stator core by more than the thickness of the insulating layer whereby the distance between the ends of the connecting portions of a pair of conductors decreases toward their ends (at least when considering the curved part 44 of the end conductor portions 42b). According to D1, paragraph [0095], "when the end portions 42 are aligned in the radial direction at the time of joining, they are brought into close contact

without a gap between the distal ends of the constant-sectional area portions 42b". Hence, in D1, the bare portion 42b of one conductor is brought in contact for connection, and is connected with the bare portion of another conductor.

The subject-matter of claim 1 of the main and auxiliary requests, as well as claim 2 of the main request differs from what is shown in figure 18 of D1 in that each segment of the plurality of conductors has a substantially rectangular cross-section.

Document D1 discloses different embodiments with conductors having round cross sections (embodiments shown in figures 1, 10 and 18) or substantially rectangular cross sections (embodiments shown in figures 12, 14, 16 and 17). It does not however explicitly suggest the combination of the embodiment of figure 18 with the conductors of one of the embodiments shown in figures 12, 14, 16 or 17. The subject-matter of the independent claims of the main and auxiliary requests is therefore new having regard to D1.

4. *Inventive step: main and auxiliary requests*

4.1 The problem to be solved by the use of conductor segments having a substantially rectangular cross-section may be regarded as increasing the efficiency of the electrical machine of D1. It is however well-known to the person skilled in the art that the efficiency of an electrical machine may be increased by increasing the filling factor of the slots of the stator and that the use of conductors with substantially rectangular cross-section leads to an improved filling factor. The

board considers therefore that it would be obvious to a person skilled in the art, aware of a machine with a stator according to D1, and who would like to improve the efficiency of the machine, to replace the round conductors of the seventh embodiment of D1 (figure 18) with conductors having a substantially rectangular cross section. He would then arrive at a stator according to claim 1 of the main request without exercising any inventive skill.

The subject-matter of claim 1 of the main request is therefore not considered as involving an inventive step in the sense of Article 56 EPC.

The features of the method claim 2 of the main request corresponding to the features of the apparatus claim 1, no inventive step can be seen in the subject-matter of claim 2 either.

4.2 The subject-matter of claim 1 of the auxiliary request is further defined by "passing a plurality of conductors (331, 332), after having the connecting portions (331d, 331d', 331e, 331e', 332d, 332d') shaped in the altering step through each slot (35)". This provides the advantage that the altering step can be performed more easily since the conductors are not yet inserted into the stator core.
Document D1 does not address the problem of the insertion of the conductors in the slots. According to the appellant, a reason may be that D1 mainly considers stators with round conductors. Those stators present a lower filling factor than stators with conductors having a substantially rectangular cross-section. Because of the lower filling factor, there is more

space available in the slots for the insertion of conductors having a round cross-section than for conductors having substantially rectangular cross-section. The skilled person, who is aware that conductors with rectangular cross-section would normally fill the slots completely, would consider that such conductors would not be inserted into the stator core if their end portions were altered as specified in claim 1 of the auxiliary request.

The person skilled in the art in knowledge of D1 would therefore refrain from altering the conductors before their insertion in the stator core.

The appellant admitted that the insertion into the slots of conductor segments as claimed would require a certain play which would result in a reduced filling factor compared with the maximum filling factor achievable with conductors having substantially rectangular cross-section but no altered end portion. However, the necessary play could be kept to a minimum value corresponding to the space needed to pass only one of the pair of conductors in a slot, resulting in an improved filling factor compared with conductors having circular cross-section as shown in D1. Since this possibility and the related advantage of improved filling factor cannot be regarded as obvious to the skilled person having regard to D1 and the other documents cited in the decision under appeal, the subject-matter of claim 1 of the auxiliary request is considered as involving an inventive step in the sense of Article 56 EPC.

5. The subject-matter of claims 2 to 6, which are dependent on claim 1, is thereby also to be considered as being new and involving an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:

Description
Pages 3 to 12 as originally filed,
Page 2a filed with the letter dated 2 September 2011 as page 2a of the amended description according to the auxiliary request,
Pages 1, 2, 13 and 14 filed at the oral proceedings of 4 October 2011.

Claims
No. 1 to 6 of the auxiliary request filed at the oral proceedings of 4 October 2011.

Drawings
Figures 1 to 9 as originally filed.

The Registrar: The Chairman:

C. Moser M. Ruggiu